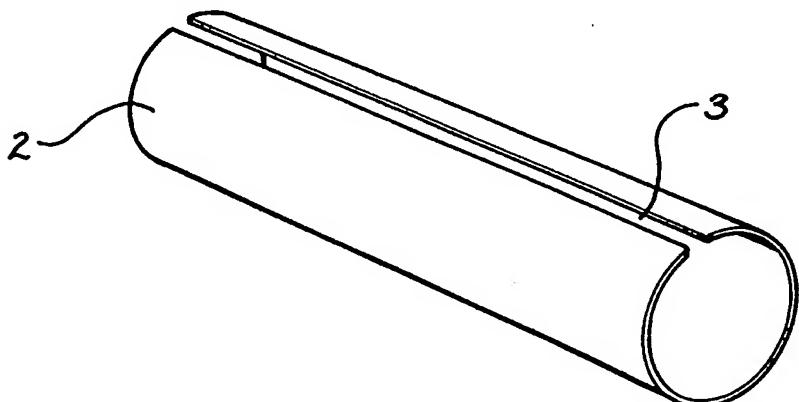


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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>6</sup> : <b>B21D 51/00, 51/10, 51/30</b>		A1	(11) International Publication Number: <b>WO 00/03818</b> (43) International Publication Date: <b>27 January 2000 (27.01.00)</b>
(21) International Application Number: <b>PCT/AU99/00554</b> (22) International Filing Date: <b>8 July 1999 (08.07.99)</b>  (30) Priority Data: <b>PP 4702</b> 15 July 1998 (15.07.98) AU		(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).	
(71)(72) Applicant and Inventor: <b>SIMMONS, Anthony, Grant [AU/AU]; 3 Ellis Avenue, Alexandria, NSW 2015 (AU).</b>  (74) Agent: <b>F B RICE &amp; CO.; 605 Darling Street, Balmain, NSW 2041 (AU).</b>		Published <i>With international search report.</i>	
(54) Title: <b>VEHICLE WHEEL RIM SECTION</b>			
(57) Abstract			
<p>The present invention concerns the method of forming a vehicle wheel rim section (5) from rolled sheet metal (2). In another aspect, the invention concerns a vehicle wheel rim section (5) constructed using the method. The invention is applicable to the manufacture of vehicle wheels having a rim section and a separate hub or centre. The method involves rolling the sheet metal (1) into a circular form (2), and friction welding the edges (3) of the circular form together to make a pre-form cylinder.</p>			
			

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## VEHICLE WHEEL RIM SECTION

### **Technical Field**

The present invention concerns the method of forming a vehicle wheel  
5 rim section from rolled sheet metal.

In another aspect, the invention concerns a vehicle wheel rim section  
constructed using the method. The invention is applicable to the  
manufacture of vehicle wheels having a rim section and a separate hub or  
centre.

10

### **Background Art**

The friction stir welding process has recently been developed, and is  
described in WO 93/10935. This document describes how workpieces are  
joined by plasticising and then consolidating the material about a joint line.  
15 This is achieved by a rotating tool which comprises a pin and a shoulder.  
The pin is inserted in the joint so that the shoulder touches either side of the  
joint. The pin and shoulder are then rotated so that friction between them  
and the work pieces plasticises the metal around the pin. The pin is moved  
forward along the joint line and the plasticised material behind the pin  
20 consolidates and cools.

### **Summary of the Invention**

A first aspect of the invention is a method of forming a vehicle wheel  
rim section, the method including the steps of:  
25 rolling the sheet metal into a circular form; and  
friction welding the edges of the circular form together to make a pre-  
form cylinder.

There are a number of advantages of friction stir welding that make it  
particularly suitable for this purpose. For instance, the process is quiet, uses  
30 little energy and can be performed on relatively inexpensive machines.

After extensive research it has been found that the post-weld  
formability of the joints in the pre-form cylinders allows subsequent  
formation of the wheel rim shape without significant loss of strength. Most  
welded joints exhibit very different formability characteristics when  
35 compared to the parent metal, and many will crack if subjected to extensive  
working or stretching. Friction stir welding has been found to give good

5 performance in this regard. The appearance and colour matching of the weld zone to the unwelded portion of the rim have also been found to be highly satisfactory. A good initial appearance is improved during forming to the point that, except for a slight colour variation compared with the unwelded metal, the weld is almost undetectable. Even this colour variation disappears when the rim is given a light polish.

10 Further steps in the method of forming the wheel rim may include forming the pre-form cylinder into the desired rim profile. Also, a heat treatment process, such as a solution and precipitation treatment, may also be employed to achieve the required temper.

A second aspect of the invention is a vehicle wheel rim section including a rim section made according to the process.

The rim section may be bolted to a cast wheel centre and outside rim to form a three piece wheel.

15 A third aspect of the invention is a vehicle wheel made according to the process.

20 The sheet metal, and therefore the pre-form cylinder, may have a length sufficient to construct one vehicle rim section, or it may advantageously be in the form of a longer cylinder which is parted to form several individual rim sections. The advantage of forming the longer cylinder first is that the beginning and end of the welded seam can be discarded and so do not interfere with the finished result.

25 In one example of the invention, a sheet of aluminium alloy 6061 in the fully annealed O temper was rolled into a circular form, and then friction stir welded into a pre-form cylinder. A purpose-built machine was used to make the friction stir welded joint. After the joint was formed the welded joint did not require any cleaning up. The material was subsequently formed into the required profile in O temper, and then subjected to heat treatment to achieve the required T6 temper. The rim section was then bolted to a cast wheel centre and to an outside rim to form a three piece wheel. This wheel performed well when subjected to a radial fatigue test on a roller machine.

30 The rim may also be made from other metals and alloys including steel and titanium.

### Brief Description of the Drawings

An example of the invention will now be described with reference to the accompanying drawings, in which:

- 5      Figure 1 is a pictorial view of a sheet of aluminium;
- Figure 2 is a pictorial view of the sheet aluminium of Figure 1 after it has been rolled into a circular form;
- Figure 3 is a pictorial view of a section that has been parted from the cylinder;
- 10     Figure 4 is a pictorial view of a rim section after it has been formed from the section of Figure 3; and
- Figure 5 is a pictorial view of the rim section connected in to a wheel.

### Detailed Description of the Best Mode of the Invention

Referring first to Figure 1 a sheet 1 of aluminium alloy 6061 in the 15 fully annealed O temper is rolled into a circular form 2, as shown in Figure 2. The metal is then friction stir welded along the seam 3 to make a pre-form cylinder. A purpose-built machine is used to make the friction stir welded joint. After the joint was formed the welded joint did not require any cleaning up.

20     A section 4 is then parted from the pre-form cylinder, as shown in Figure 3. The section 4 is subsequently formed into the required profile 5, as shown in Figure 4, while the aluminium remains in O temper.

The rim section 5 is then subjected to heat treatment to achieve the required T6 temper. The rim section 5 is then bolted to a cast wheel centre 6 25 and to an outside rim 7 to form a three piece wheel 8, as shown in Figure 5. This wheel 8 performed well when subjected to a radial fatigue test on a roller machine.

Although the invention has been described with reference to a 30 particular example it should be appreciated that many variations are possible, and that many different wheels may be produced. For example, many other alloys and metals may be employed in the construction of wheels using the method.

It will be appreciated by persons skilled in the art that numerous variations and/or modifications may be made to the invention as shown in the specific embodiments without departing from the spirit or scope of the  
5 invention as broadly described. The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive.

## CLAIMS:

1. A method of forming a vehicle wheel rim section, the method including the steps of:
  - 5 rolling the sheet metal into a circular form; and
  - friction welding the edges of the circular form together to make a pre-form cylinder.
2. A method according to claim 1, including the further step of post-weld forming the cylinder.
3. A method according to claim 2, where the post-weld forming includes 10 forming the pre-form cylinder into a desired rim profile.
4. A method according to claim 2 or 3, where a heat treatment process is also employed to achieve the required temper.
5. A method according to claim 4, where the heat treatment process is a solution and precipitation treatment.
- 15 6. A method according to claim 1, where the sheet metal, and therefore the pre-form cylinder, has a length sufficient to construct one vehicle rim section.
7. A method according to claim 1, comprising the further step of parting the pre-form cylinder into several individual rim sections.
- 20 8. A method according to claim 1, where the sheet metal is aluminium alloy 6061 in the fully annealed O temper, and the pre-form cylinder is subsequently formed into the required rim section profile in O temper.
9. A method according to claim 8, comprising the further step of subjecting the rim section to heat treatment to achieve the required T6 temper.
- 25 10. A method according to any preceding claim, comprising the further step of bolting the rim section to a cast wheel centre and to an outside rim to form a three piece wheel.
11. A vehicle wheel rim section made according to the process of any one 30 of claims 1 to 9.
12. A vehicle wheel made according to the process of claim 10.

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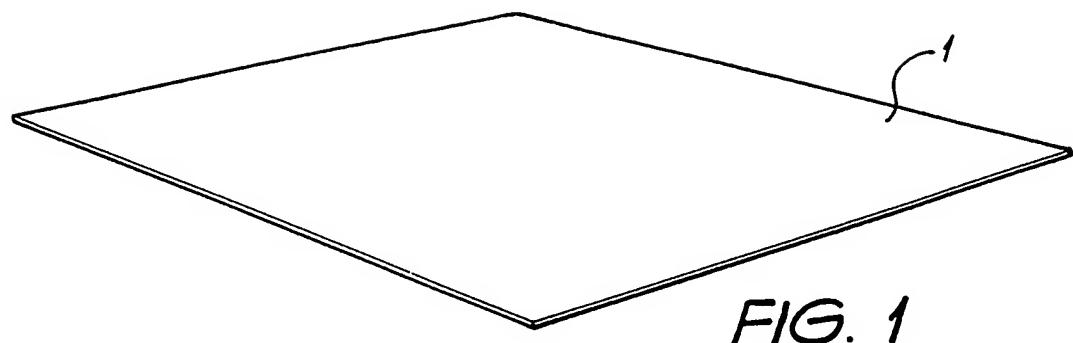


FIG. 1

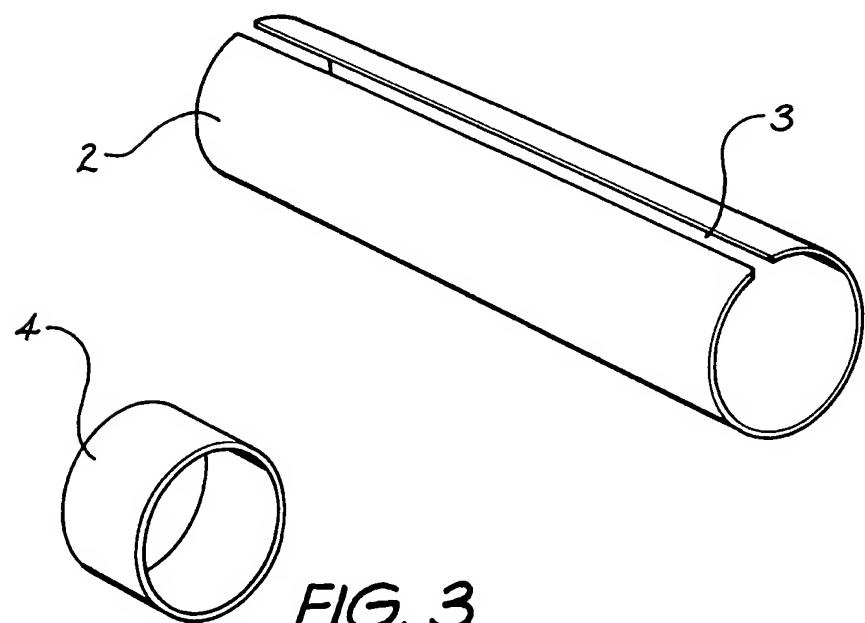


FIG. 2

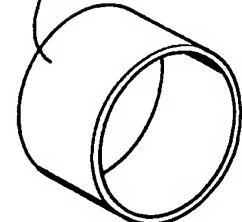


FIG. 3

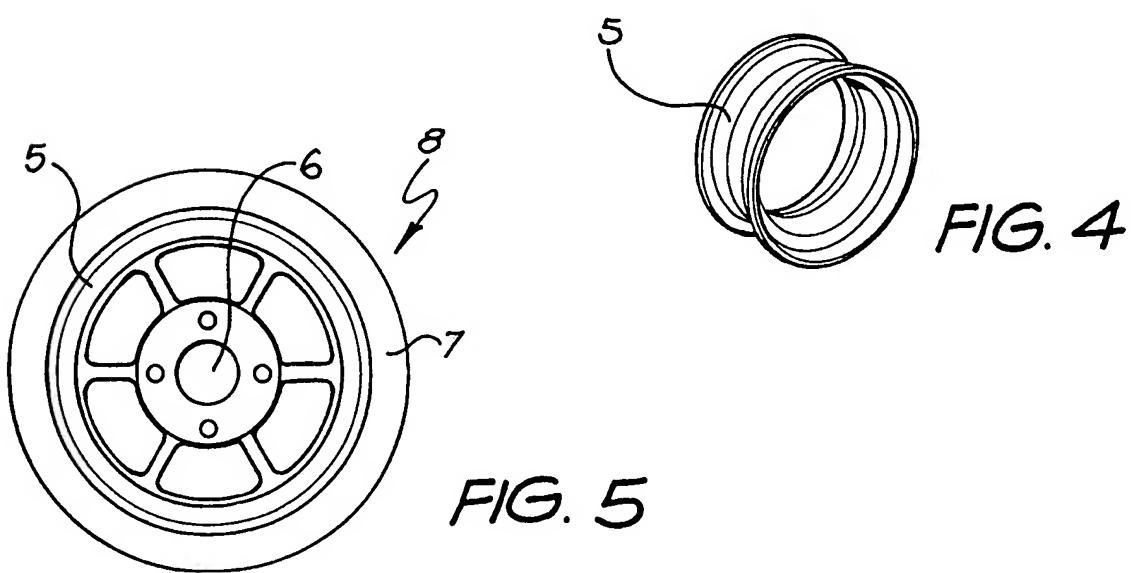


FIG. 4

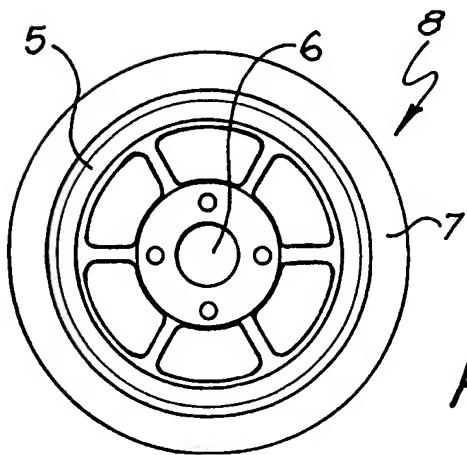


FIG. 5

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU 99/00554

<b>A. CLASSIFICATION OF SUBJECT MATTER</b>		
Int Cl <sup>6</sup> : <b>B21D 51/00, 51/10, 51/30</b> According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b>		
Minimum documentation searched (classification system followed by classification symbols)  <b>IPC B21D 51/00, 51/00,51/30</b>		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  <b>AU:IPC AS ABOVE</b>		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A  A	DERWENT ABSTRACT ACCESSION NO 97-207580/19 CLASS P52, JP-A-09-057380 9KYONO) 4 MARCH 1997  DERWENT ABSTRACTS ACCESSION NO C5766 A/13, CLASS P51, DT A, 2739962 (NIPPON STEEL CORP) 23 MARCH 1978	
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DE	2739962	CA	1052989	FR	2364074	GB	1562847
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